

WE CLAIM:

1. A composition, comprising:
a first layer comprising a material having a high power factor; and
a second layer comprising a diffusion barrier.
2. The composition according to claim 1 where the material having a high power factor has a formula $\text{Bi}_x\text{Sb}_{2-x}\text{Se}_y\text{Te}_{3-y}$, or $\text{PbSe}_z\text{Te}_{1-z}$ where $0 \leq x \leq 2$, $0 \leq y \leq 3$, and $0 \leq z \leq 1$.
3. The composition according to claim 1 where the diffusion barrier comprises a material having a formula $\text{ASe}_z\text{Te}_{2-z}$, where A is selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, and combinations thereof, and $0 \leq z \leq 2$.
4. The composition according to claim 1 where the first layer comprises at least one of Bi_2Te_3 , Sb_2Te_3 , Bi_2Se_3 , Sb_2Se_3 , TiTe_2 , HfTe_2 , ZrTe_2 , PbTe , TiSe_2 , HfSe_2 , ZrSe_2 , PbSe , alloys thereof, and combinations thereof.
5. The composition according to claim 1 where the first layer and the second layer are repeating layers forming a superlattice.
6. The composition according to claim 1 where the first layer and the second layer form a repeating unit.
7. The composition according to claim 5 where the first repeating layer comprises Bi_2Te_3 .
8. The composition according to claim 1 where the first layer includes Bi_2Te_3 , and the second layer includes TiTe_2 .

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9. The composition according to claim 5 where the first repeating layer comprises Sb_2Te_3 .

10. The composition according to claim 5 where the second repeating layer comprises HfTe_2 , TiTe_2 , or both.

11. The composition according to claim 5 further comprising a third repeating layer.

12. The composition according to claim 11 where the third repeating layer comprises a material having a formula $\text{Bi}_x\text{Sb}_{2-x}\text{Se}_y\text{Te}_{3-y}$, or $\text{PbSe}_z\text{Te}_{1-z}$ where $0 \leq x \leq 2$, $0 \leq y \leq 3$, and $0 \leq z \leq 1$.

13. The composition according to claim 11 further comprising a fourth repeating layer.

14. The composition according to claim 13 where the fourth repeating layer comprises a diffusion barrier material.

15. The composition according to claim 13 where the fourth repeating layer comprises a material having a formula $\text{ASe}_z\text{Te}_{2-z}$, where A is selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, and combinations thereof, and $0 \leq z \leq 2$.

16. The composition according to claim 11 where each layer is from about 3 to about 200 Å thick

17. The composition according to claim 13 where the first, second, third and fourth layers comprise a repeating unit.

18. The composition according to claim 13 where the first layer comprises Bi_2Te_3 .

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19. The composition according to claim 13 where the second layer comprises TiTe_2 .

20. The composition according to claim 6 where the repeating unit is from about 6 to about 500 Å thick.

21. The composition according to claim 6 where the repeating unit is from about 40 to about 100 Å thick.

22. The composition according to claim 11 comprising Bi_2Te_3 , TiTe_2 , and Sb_2Te_3 .

23. The superlattice according to claim 13 where the second and fourth layers comprise a material having a formula $\text{ASe}_z\text{Te}_{2-z}$, where A is selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, and combinations thereof, and $0 \leq z \leq 2$.

24. The composition according to claim 23 where each layer of the repeating unit comprises at least one of Bi_2Te_3 , TiTe_2 , and Sb_2Te_3 .

25. The composition according to claim 17 comprising a repeating unit having a first layer including Bi_2Te_3 , a second layer including TiTe_2 , a third layer including Sb_2Te_3 , and a fourth layer including TiTe_2 .

26. A method for making a thermoelectric superlattice, comprising:
synthesizing a first material, the first material having a formula $\text{Bi}_x\text{Sb}_2\text{Se}_y\text{Te}_{3-y}$, or $\text{PbSe}_z\text{Te}_{1-z}$ where $0 \leq x \leq 2$, $0 \leq y \leq 3$, and $0 \leq z \leq 1$; and
synthesizing a second material on the first material, the second material being a diffusion barrier.

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27. The method according to claim 26 where the second material has the formula ASe_zTe_{2-z} , where A is selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, and combinations thereof, and $0 \leq z \leq 2$.

28. The method according to claim 26 where the first material is synthesized by MER.

29. The method according to claim 26 further comprising synthesizing a third material, the third material having a formula $Bi_xSb_{2-x}Se_yTe_{3-y}$, or $PbSe_zTe_{1-z}$ where $0 \leq x \leq 2$, $0 \leq y \leq 3$, and $0 \leq z \leq 1$.

30. The method according to claim 26 where the second material is synthesized by MER.

31. The method according to claim 29 further comprising synthesizing a fourth material, the fourth material being a diffusion barrier.

32. The method according to claim 26 where the first material and the second material are synthesized as a repeating unit.